1994
Executive Research Project
S3

Making Dual-Use Work: Revising Government/Industry Relationships

Lieutenant Colonel
William J. Barattino
United States Air Force

Faculty Research Advisor
Dr. Edwin R. Carlisle

The Industrial College of the Armed Forces
National Defense University
Fort McNair, Washington, D.C. 20319-6000

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY N/A	3. DISTRIBUTION/AVAILABILITY OF REPORT Distribution Statement A: Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NDU-ICAF-94-S3	5. MONITORING ORGANIZATION REPORT NUMBER(S) Same
6a. NAME OF PERFORMING ORGANIZATION Industrial College of the Armed Forces 6b. OFFICE SYMBOL (If applicable) ICAF-FAP	7a. NAME OF MONITORING ORGANIZATION National Defense University
6c. ADDRESS (City, State, and ZIP Code) Fort Lesley J. McNair Washington, D.C. 20319-6000	7b. ADDRESS (City, State, and ZIP Code) Fort Lesley J. McNair Washington, D.C. 20319-6000
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. | PROJECT NO. | TASK NO. | WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification) Making Dual-Use Work: Revising Government/Industry Relationships

12. PERSONAL AUTHOR(S) William J. Barattino

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Research	FROM Aug 93 TO Apr 94	April 1994	50

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

SEE ATTACHED

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Judy Clark	22b. TELEPHONE (Include Area Code) (202) 475-1889 22c. OFFICE SYMBOL ICAF-FAP

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

ABSTRACT

The Clinton Administration intends to promote the economic growth of our nation by encouraging development of technologies with potential for use in either the civilian or military sectors. The deluge of articles dealing with dual-use technologies can be lumped into two major categories: macroeconomics effects and technologies. What's missing from these discussions is a critically important aspect of the dual-use paradigm - variations in the relationships between the government and the private sector firms. This paper represents the first serious attempt to fill this void in the literature by exploring in detail the potential dual-use relationships. Four distinct dual-use models are defined as: Spin-off, Spin-on, Military/Industry Joint Ventures, and Defense Infrastructure Support. Each model is characterized in terms of the government/industry relationships, the actors and their motivations, the key attributes, and the cultural changes within the DOD required for implementation. Several examples of dual-use alternatives to the traditional spin-off model are provided.

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I'd like to thank a member of the ICAF faculty, Dr. Ed Carlisle, for his continued support throughout this research project. He was instrumental in my reframing from a purely technology lens to an economic and strategic one, as well. The many hours he dedicated to discussing and challenging my views was most beneficial to me. Thanks Ed.

I also need to thank my previous boss, Col (Ret) Ed Duff, for providing the opportunity to develop the views expressed throughout this paper. Many of the thoughts captured here were generated under his tutelage. He puts into practice on a regular basis what many will only talk about getting done someday. Thanks Ed.

ABSTRACT

The Clinton Administration intends to promote the economic growth of our nation by encouraging development of technologies with potential for use in either the civilian or military sectors. The deluge of articles dealing with dual-use technologies can be lumped into two major categories: macroeconomics effects and technologies. What's missing from these discussions is a critically important aspect of the dual-use paradigm - variations in the relationships between the government and the private sector firms. This paper represents the first serious attempt to fill this void in the literature by exploring in detail the potential dual-use relationships. Four distinct dual-use models are defined as: Spin-off, Spin-on, Military/Industry Joint Ventures, and Defense Infrastructure Support. Each model is characterized in terms of the government/industry relationships, the actors and their motivations, the key attributes, and the cultural changes within the DOD required for implementation. Several examples of dual-use alternatives to the traditional spin-off model are provided.

INTRODUCTION

The Clinton Administration intends to promote the economic growth of our nation by encouraging development of technologies with potential for use in either the civilian or military sectors. In the Bottom-Up Review, Secretary Aspin issued a major challenge to the defense acquisition community in his call for the DOD to ". . . actively assist in the transition of the U.S. economy away from a Cold War footing." [Aspin, p.10] This call for implementation of dual-use activities within defense acquisition could have far reaching consequences on what and how we do business.

The deluge of articles dealing with dual-use technologies can be lumped into two major categories: macroeconomics effects and technologies. The first focuses on important national issues such as the percentage of R&D dollars spent on defense compared with our industrial competitors. The second category focuses on technologies that have dual-use potential with each author favoring his own favorite application that's being pushed.

What's missing from these discussions is a critically important aspect of the dual-use paradigm - variations in the relationships between the government and the private sector firms. The relationships can take several forms and each one has a its own unique characteristics which must be considered when implementing dual-use strategies. Alic and his fellow Harvard researchers did present this aspect of dual-use, but only in a very precursory manner. [Alic, pp. 64-75]

This paper represents the first serious attempt to fill this void in the literature by exploring in detail the potential dual-use relationships. Each model is characterized in terms of the government/industry relationships, the actors and their motivations, the key attributes, and the cultural changes within the DOD required for implementation. Several examples of dual-use alternatives to the traditional spin-off model are provided.

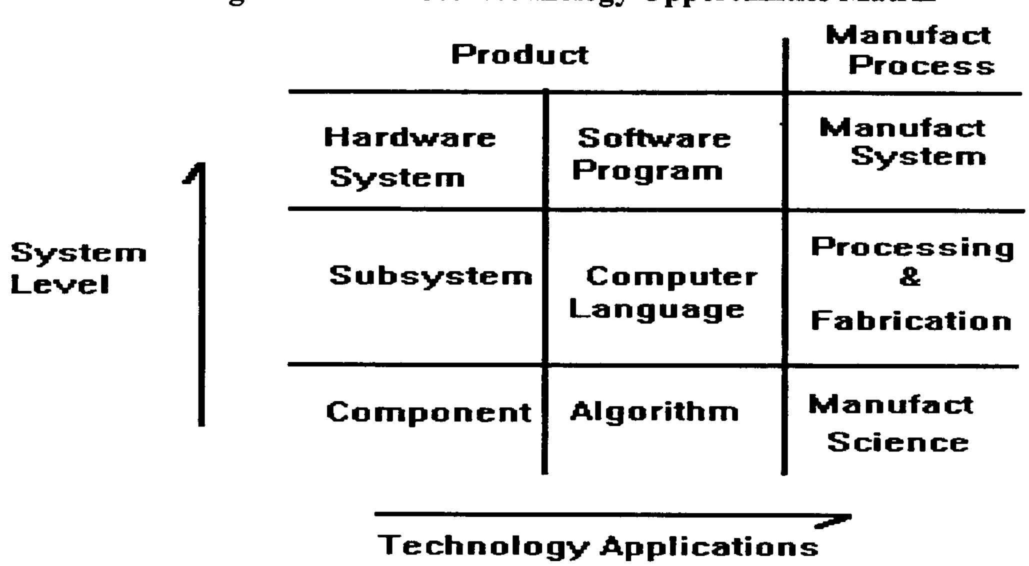
WHAT IS DUAL-USE?

Before jumping into the relationship models, some preliminaries must be covered. In my research for this paper, it became clear that most authors had their own view of what dual-use meant. The difficulty was that rarely was the view defined or even explicitly stated. This lack of grounding of basic definitions can lead to much confusion in the dual-use debate, as the participants may not even be reading from the same sheet of music. For this reason, I think it is imperative that some attention be given to establishing a common frame of reference.

Our discussion of dual-use technologies begins with its definition as those technologies which have both commercial and military use. [Alic, p.4] I'll take this top level definition another step by breaking dual-use down further into two parts: **technology opportunities** and the **relationships** between government and industry during technology development.

Figure 1 portrays technology opportunities as a matrix of potential dual-use options. The vertical axis of the matrix represents the system level at which dual-use opportunities occur, progressing from the prime item to the total system application (i.e. a GPS satellite or a GPS receiver). The horizontal axis reflects the wide range of potential civilian/military applications: hardware, software and even manufacturing systems.

Figure 1: Dual-Use Technology Opportunities Matrix



Even with the downturn in defense spending, military acquisition affords dual-use opportunities at virtually any part of the matrix. With our decentralized execution of defense acquisition programs across a large number of organizations, guidance from the top to emphasize dual-use ventures with the private sector will undoubtedly lead to a variety of combinations of system levels and applications.

The second part of our dual-use technologies definition focuses on the potential relationships between government and industry during the conduct of the research. Almost all discussions of dual-use have addressed some aspect of the technology opportunities, with a plethora of opinions offered on each authors favorite dual-use mission for defense to tackle. There has been very little intellectual discussion on this second part of the dual-use definition, the relationships dimension. It's now time to correct this deficiency.

Traditionally, defense R&D programs have 'spun-off' technologies into the commercial sector on an ad-hoc basis. While spawning of new commercial opportunities was not the objective for defense, such occurrences were acceptable as long as national security risks were not involved.

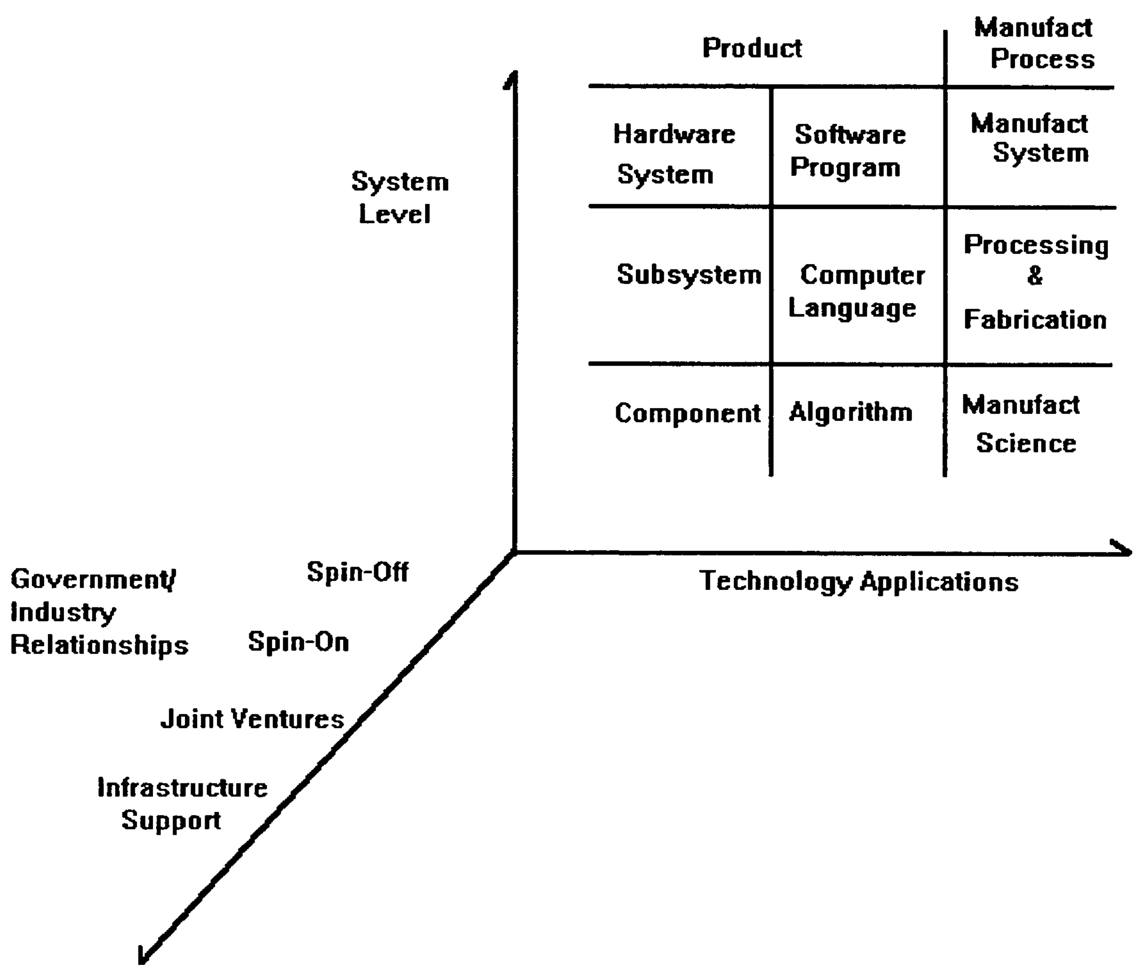
The spin-off model is but one of several types of potential government/industry relationships. Four distinct dual-use models are defined as:

1. Spin-off
2. Spin-on
3. Military/Industry Joint Ventures
4. Defense Infrastructure Support
    a. Military Pull
    b. Military Support

Discussions of dual-use implementation must address both technology opportunities and the potential government/industry relationships. Consideration of both aspects of dual-use technologies can complicate these discussions dramatically as demonstrated with

figure 2. As if the opportunities matrix of figure 1 wasn't enough to ponder, a third dimension to the dual-use definition has been introduced with the inclusion of the relationships aspect. However, if dual-use is to become a cornerstone of defense R&D, it is imperative that we fully understand the implications of these relationships before moving too far down this path. Let's now discuss the details of each relationship model.

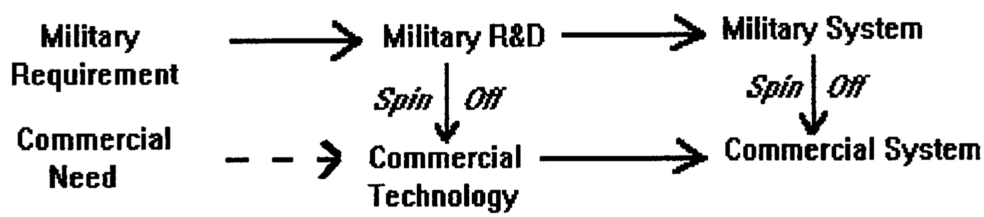
Figure 2: 3-D Matrix Representation of Dual-Use Opportunities



1.0 THE BASELINE: SPIN-OFF MODEL

a. Model Description

Figure 3: Spin-Off Model Interrelationships



The primary relationships between government and industry under the spin-off model are contained in figure 3. The military requirement, as defined by war fighting needs, is translated into performance requirements. Assuming that existing systems cannot meet this need, the acquisition community responds with a program to develop a new system to provide this capability. The military research and development effort then proceeds through the standard defense acquisition cycle to produce the military system. *Spin-off* occurs when either the military technology or system is used by the commercial market.

b. Actors Involved

To implement the defense acquisition process, four distinct communities have emerged within the government:

- Science and Technology (for 6.1 thru 6.3a funds)
- Program Management (for programs in the acquisition process)
- Contract Management
- Test and Evaluation

All of these communities have developed their own cultures and have considerable influence on the government/industry relationships. Science and Technology is structured such that resources are allocated centrally by OSD/DDR&E, through the military services' materiel commands, to the military laboratories. The S&T community determines which technologies receive funding at the basic and exploratory research levels (i.e. 6.1 and 6.2

funds), without direct input from the operational community. As the research begins to take an applied shape in the form of a military application, the projects are packaged as advanced technology demonstrations and the operators begin to have input in the resource allocation process.

Once a system is deemed ready to enter the acquisition cycle, a program manager is assigned to guide the effort through the acquisition process to fielding a new capability. As previously discussed, dual-use also encompasses system and subsystem level applications. Therefore, program managers can also be expected to play a major role in future dual-use programs. The program manager's contract with his customer is the acquisition program baseline, which represents an agreement between the developer and the user of the program performance, cost, and schedule objectives. [DODI 5000.2, Part 11, Section A, p.11-A-1]

Thus, we see that both science and program managers have to respond to a clearly defined audience and set of objectives in executing their program. The spin-off model does not require them to expand their perspective beyond their immediate customer. With a heavy emphasis on performance in defense R&D programs, the focus has been on pushing technology far beyond current limits to maintain user support for continued funding of the program, with less concern on the cost and schedule impacts.

The actors on the industry side of the team were modeled after the government structure. Defense marketing representatives knew their customers needs very well. There was reasonable stability within the industry teams, particularly at the science and technology level. As long as defense procurement remained well funded, the R&D needs of defense contractors were adequately supported. [Lichtenburg, p.557] And with a return to cost plus contracts for higher risk programs, the industry program manager could maintain reasonable support from his corporate management for duration of the program's lifetime.

c. **Key Attributes**

- **Single Objective is to Satisfy Military Need**

The spin-off model is the basis for characterizing defense R&D since World War II. The name itself comes from realization that the only objective of the research is to produce a military system. If the resulting system or technology produced technology that had commercial potential, that was generally acceptable; however, the commercialization potential was not a factor in allocating defense resources. The acquisition program survived or failed based solely on its merits in developing a military system capable of meeting the military requirement.

The military requirement provides the basis for all research under spin-off. During the Cold War, the overriding concern was to meet performance requirements extracted from the requirements, usually at the expense of cost and schedule goals. This heavy emphasis on performance is often attributed to be a pre-determined characteristic of spin-off, but this is a fallacious argument. In a bi-polar environment where perception was as important as reality in defining the responses of the superpowers, our pre-occupation with pushing the performance envelope was a management priority which could apply equally to any of the dual-use models.

Under current acquisition procedures, the requirements must be validated at each major milestone review before entering the next phase of the program. [DODD 5000.1, Part 2, pp.2-1 to 2-5] A common occurrence in many programs was for requirements creep to increase the technical performance goals of the system, at the expense of increased costs and schedule slips. This problem also is not unique to the spin-off model, but rather the result of an acquisition process that took many years to produce a fielded system against an enemy that was constantly upgrading his forces, as well.

The process to validate the military requirements is very deliberate. The Vice Chairman of the Joint Chiefs of Staff chairs a committee comprised of key representatives from OSD and the military services to perform this task. This group is called the Joint

Requirements Oversight Committee, JROC. [DODD 5000.1, Part 2, p.2-4] Because the requirement is critical in driving the system to be developed, requirements validation demands a very good scrub by the JROC. Hence, once a requirement receives JROC blessing, there is reluctance to reconvene this group until the next phase of the program. This requirements definition process has evolved over time based on the spin-off model. We'll see later that some revision of this process will be necessary for other dual-use models.

- **Defense Acquisition Regulations Discourage Commercial Application of Defense R&D**

Because the primary focus of the spin-off model is to produce military systems, the defense acquisition regulations were written to discourage industry from using defense dollars to produce commercial products. Contractors that produce military and commercial systems are forced to go to great lengths to maintain separate accounting systems. Most companies organizationally separate into distinct divisions to keep government auditors content. This schism was a by-product of a spin-off environment where military specs drive the military system and cost control drives the commercial system. [OTA, p.7]

- **Provides Most Control for Program Manager**

The most appealing aspect of spin-off to the defense manager is that it provides the most control for the acquisition community over meeting program cost, schedule, and performance requirements, as compared with the other models. The reason for this is that all aspects of the program are dictated by the program manager. If the system needs components or subsystems that are not available to meet performance goals, then the contractor will be responsible for developing the item as part of the overall program.

The price for more control over meeting performance requirements is higher program costs. In effect, the spin-off model represents a buy-down of program risk with higher

cost premiums. A frequent problem with defense acquisition has been a lack of self-control in defining the requirements, commonly referred to as 'requirements creep.' Often, this has led to performance requirements beyond those dictated by the threat, squandering the value of the lower risk premium. One may conclude that the inherent control over one's destiny with spin-off requires a higher level of self-discipline in requirements definition than some of the models about to be discussed.

- **Extensive Reliance on Military Specifications**

The spin-off model has traditionally meant extensive use of military specifications at all levels of a system design. An outcome of over reliance on mil-specs is that the program office required less oversight at the second and third tier contractors. Compliance with a rigid set of specifications by subcontractors provided high confidence in performance at the component level. Random quality control checks were generally sufficient to ensure that the subcontractors were indeed meeting the specs. Again we witness the trade of higher costs for lower program risk.

All risks are not mitigated with extensive use of mil-specs. The number of components produced for military unique systems can be far fewer than components in use in the commercial sector (DOD accounts for only 5% of the U.S. GDP. [U.S. Dept. of Commerce, p.32]) With a smaller population to provide feedback on components working as intended, the probability of catching product defects early in development is much reduced. This, in turn, leads to fewer opportunities to wring out performance defects in the products prior to delivery of the final system to the military user. In effect, the government had to be more concerned that the mil-spec components did indeed perform as intended under spin-off.

- **Allows for More Active Participation by Congress**

Another detriment to more program control under spin-off is the potential for more political control exerted by Congress. The enhanced ability to control inherently implies a greater opportunity to direct how the program is executed. The opportunities for building

strong coalitions for selected programs naturally follows. Also, the industrial base, particularly at the subcontractor level, becomes more dependent for survival on the program. Hence, these constituencies have greater incentives to fight for the continuation of programs, sometimes beyond their usefulness to war fighting capabilities. These parties often turn to their Congressional representatives for continued funding. The political costs for terminating spin-off programs beyond their useful lifetimes can become very high. [Cohen and Noll, pp. 240-243] Although impossible to quantify, there are opportunity costs associated with losing the flexibility to shift limited defense resources into more productive R&D programs.

d. Cultural Changes Required

Because the spin-off model has been extensively used within DOD since WWII, the R&D community has institutionalized the culture necessary to function under this model. This is not meant to imply that the current downsizing in defense budgets will not require changes within this community even if spin-off remained the dominant model for the future. In an era of austere research budgets, basic improvements will be necessary such as consolidation of the number of S&T actors, elimination of duplicative programs among the remaining actors, and better responsiveness by the weapon developers to user needs. While these improvements pose major challenges to implement, they still represent fine tuning of the current culture within defense R&D when compared with other dual-use models.

A potentially large cultural change could be the requirement levied on Program Managers to maximize spin-off opportunities in implementing their program. Some type of incentives would have to be devised to get the PMs behind such an initiative. However, exacting yet another requirement on an already overburdened PM must be carefully thought through.

2.0 SPIN-ON MODEL

a. Model Description

Figure 4: Spin-On Model Interrelationships

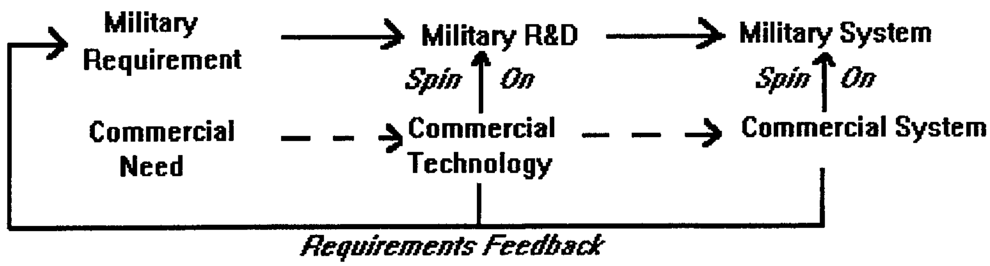


Figure 4 diagrams the interrelationships between government and industry under the spin-on model. The concept here is that military acquisition programs use technology developed for commercial markets to the maximum extent possible. The belief is that commercial products can satisfy most acquisition needs at the component and possibly subsystem level, even for major weapon systems that have no commercial counterpart. [Brooks and Branscomb, p.57] True spin-on means that the commercial market provides all technology. The military requrement, which was originally generated solely on the warfighting need, requires a feedback loop for revisiting the requirement when the status of commercial technology is factored in.

The two major reasons often cited for considering the spin-on model are:

1. To focus more attention on commercial technologies that will boost the U.S. competitive position in world trade. The Clinton Administration hopes to fund this initiative by reducing DOD's portion of federal R&D resources from 60% to 50% or less. [Gibbons, p. G-2]
2. To enhance DOD's use of the latest technologies in selected areas such as electronics and computer software. [Deutch, pp. B-1 to B-4]

The first goal of saving money with commercial items must be considered on a life cycle cost basis. **If savings achieved with lower R&D costs are exceeded by higher operations and maintenance costs, then the intent of the dual use thrust will have**

been violated. Therefore, the performance trades must factor in the support tail required during the lifetime of the system or a sub optimum solution may well result.

The second goal of tapping into the best new technologies must be conditioned by the requirements regarding the environment in which the system will have to operate during its lifetime. The best electronics board is not necessarily the one with the highest throughput of data, but possibly the one that has sufficient data transfer and will continue to function when exposed to a variety of weather and road conditions. These kinds of detailed performance-cost-logistics-requirement trades must be conducted at the beginning of a program's life. This is a fundamental difference between spin-on and spin-off models.

b. Actors Involved

The R&D for spin-on technologies is performed by the private sector in response to commercial needs. This model cuts out the defense S&T community from any major role. For some technologies, one may envision circumstances in which the commercial product may not fit the defense system need without some modification. In this case, the S&T community may play an important role by working with the private sector developer to make this conversion. However, this type of relationship would then fall under the joint venture model and will be discussed in the next section.

The program manager and his staff will ultimately be responsible for the selection and performance of the dual-use technologies. Without the support of mil-specs to rely on, the program office will be forced to place more confidence in the prime contractor's judgment to select lower tier contractors and their products. Nevertheless, some set of commercial standards will have to be invoked in selection of commercial products. Early in the program life, probably no later than the preliminary design review, the criteria for selection of commercial systems that the prime contractor uses will have to be approved by the government. A new set of system engineering reviews for dual use products may be required.

The government contracting community, along with the program office, will have a new set of concerns to address. They'll need to consider procedures to ensure that program overruns are not masked by the selection of dual-use products of inferior quality that may survive the development cycle but not much longer after being fielded. More extensive use of warranties than under spin-off may be required with spin-on.

The prime contractor will also have some major adjustments to make. For major systems, I'd envision that the system integrators will not be dramatically different than those of today (except for fewer of them). The major new actors under dual-use will be at the subcontractor levels. Since, the primary market for dual-use products will be the commercial sector, it is not reasonable to expect the defense prime contractor to have the leverage he enjoys with his predominantly captive audience of subcontractors today. In fact, it is very likely that many of the current defense subcontractors will not survive in a dual-use environment and a new set of less responsive (to defense) suppliers will be the norm for defense primes to be dealing with.

Knowledge of the financial health of a new supplier base will be a government and prime contractor responsibility to implement. Evaluation of second and third tiers of suppliers is not performed on a wide basis yet, although there is some precedence for this type of evaluations in the space community. The Air Force Space and Missile Systems Center has recently started performing this task for program managers developing space systems. [Houston, pp. 36-43]

c. **Key Attributes**

- **Requires Significant Relaxation of Military Specifications**

A fundamental ingredient to implement spin-on within defense acquisition is the flexibility to relax military standards at the component level and military requirements at the system level. The system designer must be capable of performing trade-off of technical performance for reduced costs due to adaptation of commercial systems. Once

the set of commercially available technology options is defined, the resulting trade-off in system capabilities with requirements must then occur.

- **Requires Simplification of DFAR to Attract Commercial Vendors**

The key ingredient to making spin-on a viable concept is the availability of commercial products and a willingness of the commercial vendors to sell these goods to DOD. Current legislation actually discourages companies doing business with DOD from providing these same goods to the commercial sector. [OTA, p.39] Many companies that do not need the government's business can't be bothered with the cost of complying with the maze of regulations and do not pursue this market. Obviously, a strategy that requires contractors to market their wares to the public and private sectors must be supported by a legislative environment that allows such dealings to occur. The first order of business will be to pass legislation that removes the barriers inhibiting companies from operating in a dual use mode.

- **Requires Major Revision of Requirements Generation Process**

The highly iterative process between requirements definition and capabilities assessment under spin-on could result in significant changes to the current acquisition process. The rigid structure imposed by the need for JROC approval may give way to a lengthier process with approvals delegated to much lower levels. Since few programs are expected to make it to the production phase in the future, the need for very top level approvals may also be deferred to later in the acquisition cycle.

The previously discussed trade-off between requirements and capabilities requires detailed engineering analyses that far exceed the level of analyses typical of a program so early in its lifetime. Simulation will have to satisfy this need. The difficulty is that these kinds of analysis tools are generally not developed until late in the DEMVAL phase, at best. Yet, current acquisition procedures call for firm requirements to be defined and approved at Milestone 1, before phase 1 begins. Clearly, something must change.

Maintaining the system as currently implemented may lock the program into unreasonable difficulties in meeting requirements with significant amounts of commercial technology. Breeches in program baseline from the outset could doom the program to cancellation from the very start.

An alternative approach would be to expand the concept exploration phase (phase 0) to allow for a level of analysis to be developed which provides much better understanding of the requirements/capabilities trade-off with various levels of implementation of spin-on technologies. The disadvantages of a longer period to conduct phases 0 and 1 of a program could be offset by a reduced engineering and manufacturing development phase. Less time will be needed in phase 2 to prepare for production because of the greater time spent on design details up front in the program, coupled with the reduced development time with the use of commercial parts. Hence, an early slow-down of the program compensated for with a shorter EMD phase is a defendable position. This logic trail has led to the creation of Advanced Technology Demonstrations and Advanced Concept Technology Demonstations by OSD.

- **Allows for Updates of Technology on a Regular Basis**

A major advantage of spin-on often cited is the pace which commercial technology is improved because of the competition driven environment. For example, innovation in the personal computer industry requires that suppliers upgrade their products on an aggressive schedule or be left in their competitor's dust. We've all come to accept as the norm the introduction of better, more capable PC's on a semi-annual to quarterly basis.

In contrast to the rapid upgrades to commercial technology, the approval process for defense acquisition programs requires that defense technologies be locked-in often years in advance of entering production. Multi-year procurements for major weapon programs results in new systems coming off the assembly line with fairly old technology being deployed into the field.

- **Adds Complexity to Support Requirements of Weapon Systems**

However, the disadvantage of fielding old technology conversely has the advantage of less risk in supportability requirements for the logistics community. Wide use of commercial technology at subsystem levels may result in a host of new headaches from a supportability viewpoint.

With widespread spin-on, the impacts on the support structure apply to an even greater extent. The defense system purchases may not significantly influence the design of the commercial systems. The rapid improvements in spin-on technologies will be driven by commercial sector competition. Hence, wide variations in the subsystems and below may exist even within the same weapon system. This type of situation is typical of the automotive industry. Each year produces variations in the parts required to supply the vehicle model.

So there is precedence for supporting such a system. The difficulty will be in adapting the logistics support infrastructure to meet the varying demands should spin-on become a reality within the defense community on a large scale. And with reduced budgets, the time to produce new systems will get longer; hence, even more variability in commercial technologies between production lots.

Complexity on supportability requirements of using commercial systems was already recognized as a challenge to the Air Force even before dual-use began gaining acceptance. In June 1991, a working group concluded that the current logistics infrastructure did not meet the increased support demands introduced with wide use of commercial technologies. The group concluded that these support requirements had to be identified and addressed much sooner in the acquisition process, during the development process and not as an afterthought. [CSWG, pp.8-10]

d. Cultural Changes Required

A true spin-on system significantly reduces the relevance of military labs. The R&D below the subsystem level will be performed by the commercial sector for commercial

applications. Integration of these technologies into a military system will be performed by the prime contractor.

The need for more detailed simulation during phase 0 of a program under spin-on was previously discussed. The S&T community should play a major role in the trades between requirements and capabilities. However, the skills required for this task (i.e. systems engineering with simulation) are not in abundance in the military labs. The main reason for this deficiency is that under the spin-off approach more emphasis was placed on performing the hardware dominated brassboard experiments by lab personnel. Therefore, a large scale shift to the spin-on model could result in elimination of a significant portion of the defense S&T community. The remaining segment should be refocused to support phase 0 system trade analyses of future defense programs. The labs must adapt with bringing in these new skills, or else lab personnel will be relegated to predominantly a consultant role.

The contracting community will also require significant shifts in its culture. The technical portion of the S&T community generally perceives their contracting representatives as non-responsive to their needs. As frustrating as this is to the scientists and their contractors, they are hostage to these government contracting representatives and not in a position to wield much influence. This slow responsiveness by contracting will have major deleterious effects in a spin-on environment. Second and third tier contractors will be less inclined to tolerate government foot dragging on contractual support since they will be less dependent on the government business than under the spin-off approach.

In summary, implementation of spin-on requires both structural changes by eliminating non-relevant S&T personnel and attitudinal shifts in terms of providing more responsive contracting support to clients that may not place defense business in as high a regard as the previous captive contractors.

e. Example

The Army's Precision Lightweight GPS Receiver Program provides an excellent example of spin-on acquisition in use. The details of this story are based on an excellent summary by the program manager, Colonel Bruce Sweeny. [Sweeny, pp. 38-41] GPS receivers became an important staple for the fighting soldier during Desert Storm. As a result, the Army decided to purchase tens of thousands of these receivers over the 1993-97 timeframe.

In 1990, the receiver being developed by the GPS Joint Program Office was more capable, but also an order of magnitude more expensive and heavier than its commercially available counterpart. At that time, the government's receiver weighed over 17 pounds and cost $40,000 each. However, the rapid develpment of circumstances with Saddam's invasion of Kuwait and our subsequent massive presence in the Persian Gulf area required the Army to purchase about 8,000 commercially available receivers in a hurry. These systems were not as accurate as the military ones, but cost only $4,000 each and weighed only 4 pounds. Location accuracy provided by the receiver was sufficiently improved by operational procedures, specifically by adjustments in the transmitted signals of the GPS satellites.

The great success with these commercially available versions led the Army to adopt a spin-on acquisition strategy for the follow-on, post Desert Storm buy. The resulting contract with Rockwell International, Cedar Rapids, IA, is providing the Army with receivers with unit costs starting at $1300 the first year and reducing to $772 by the last year of the buy. An additional benefit is the extremely light weight of these systems, under three pounds.

All of the characteristics outlined in section 2.0 for the spin-on model typified this program. The existing military specs for a GPS receiver were abandoned early. Instead, the program office conducted detailed performance-cost-requirement trades using the specs of the commercially available receivers. The program manager was able to get both

his user and his own engineers to remain flexible in defining the minimum essential requirements for a receiver. With this approach, several commercially available systems were deemed adequate to do the job.

The government was able to freeze the receiver requirements at a level that allowed several contractors to offer receivers which simulaneously met both commercial and military needs. The government requirements were purposely limited to define only fit, form, and function in order to allow for a dual-use product. Minimization of requirements also allowed the contractor to upgrade his product as needed to compete in the commercial sector. This approach was so successful that the Army was able to purchase 11,000 receivers during the first year of the contract when they originally thought they'd have enough dollars to purchase 2,700 sets.

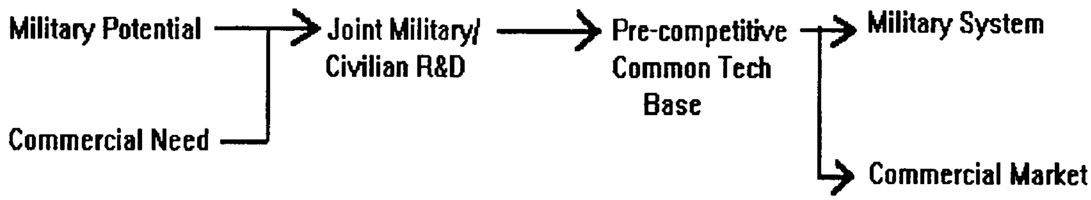
A drawback to this approach was encountered as the government was legally challenged by several contractors whose receivers did not meet the minimum performance standards required by the Army. But the courts and the GAO supported the Army position and there were a sufficient number of potential suppliers to ensure adequate competition.

One may reasonably argue that this program slightly differs from most anticipated spin-on efforts in that the commercial market (which ultimately will dwarf the military market) is still developing and the military still has more influence on the suppliers at this time as a result. However, I believe it's fair to conclude that the purchase of GPS receivers represented a truly exemplary example of a spin-on acquisition. The program manager understood the characteristics of spin-on relationships and was able to effectively invoke these principles in his acquisition strategy.

3.0 MILITARY/INDUSTRY JOINT VENTURE MODEL

a. Model Description

Figure 5: Military/Industry Joint Venture Model Interrelationships



The interrelationships between the DOD and industry under a joint venture model are diagrammed in figure 5. The key emphasis here is a common belief between both parties that a joint relationship has more benefits than either party trying to undertake the research effort alone. The motivations of both parties will differ in their final objective - developing technology for military versus commercial applications. The relevance of these varying interests will play a key role in structuring a successful joint venture. This concept will be further developed throughout this section.

Feeding the results of the R&D into a pre-competitive common technology base is a desired outcome of the government, but not necessarily of the private sector firm. The public funds invested in this work demands wide dissemination of the findings. On the other hand, protection of the investment will be expected by the company's owners. The government has tried to balance these opposing perspectives by providing the opportunity to the joint venture partner to limit access of the research results to the company for up to five years, after which the intellectual property rights revert back to the public sector. [DSMC, pp. 3.13-1 to 3.13-3]

b. Actors Involved

The military labs within the S&T community will be the key DOD player for joint ventures and will have to operate as technical marketers in developing potential industrial

partners. Using the government's technical representatives for marketing is the only means available today for this task, but it dilutes their primary objective of scientific contributions and places them in a role for which the typical government researcher has little preparation. The addition of government manpower dedicated to technical marketing would be an efficient allocation of resources under a joint venture model.

Industry's team should consist of the technical members performing R&D for the commercial applications. They will also need technical marketers familiar with the DOD S&T infrastructure and administrative support personnel that can perform under both commercial general accounting principles and government regulations.

c. Key Attributes

- **Adds More Risk Due to Joint Funding Dependency**

The key attributes of the joint venture model relates to the risk associated with counting on two partners with very different objectives continuing their support through project completion. A strong reason for teaming is to pool the limited resources of the participants. This implies that either the project is too large for any single party to fund or it doesn't have sufficient organizational support to muster enough internal resources.

Sharing of costs can also have benefits to both parties in that a critical mass may be achieved by pooling resources that may not have been possible before. For the government, the outside infusion of capital may allow continuation of research teams that would otherwise have been lost.

- **Requires Balance of Differing Perspectives Between Government and Industry**

The government must deal with the perception that it is singling out particular firms to conduct business with. The requirement in joint ventures for all parties to invest their fair share of resources necessitates government interaction with specific firms or consortiums representing selected firms. However, as the fruits of the venture come closer to producing quantifiable returns, non-participating firms often try to exert political pressure

to derail the effort. [Cohen and Noll, pp.243-252] This is a natural reaction in a competitive environment and can be expected in any successful joint venture.

A focus on high risk, long term research would mitigate the sensitivity of limiting access to research results partially supported with public funds. Of course, the five year window of opportunity defines a long term horizon of maybe two years to allow time to implement the technology into the commercial market and reap a return on investment before the competition begins.

The chances for a successful joint venture will be greatly enhanced if both parties structure the objectives of the project to accommodate the strategic needs of the respective public and private sector parties.

- **More Likely to Succeed When Focus is High Risk, Basic or Exploratory Research**

For these reasons, the chances for maintaining the continued support of all participants over many years are low. This leads me to conclude that joint ventures are more likely to be pursued for higher risk projects with a basic or exploratory research focus. This is why the starting point in figure 5 is less concrete than the firmer military requirements of the spin-off/spin-on models. Because both members of the venture are dedicating resources, both the military and commercial needs will weigh heavily in defining the objectives of the joint R&D project. The structure of the project will vary with each teaming arrangement, with any combination of facilities and people possible. The key factor required here is flexibility at the local level to establish the venture conditions. Recent legislative support has recognized this need by authorizing laboratory commanders to enter into joint ventures with industry through Cooperative Research and Development Agreements. [AFR 80-27, pp. 2-4]

- **Requires Wide Latitude in Establishing Joint Venture Agreements**

The complexity of meshing these differing perspectives into a workable venture is another reason for providing wide latitude in developing the terms each agreement that will contain provisions unique to the needs of the parties involved. The focus on early phases of the research cycle implies that the technology of the joint venture will more often support an advanced technology demonstration than directly into a military system from the acquisition cycle.

- **Requires Protection of Intellectual Property Rights**

The ability to maintain industrial partners will hinge to a large extent on how well the government supports the protection of intellectual property rights for the joint venture company. For projects that culminate in technological improvements with high commercial value, the government must trade-off the benefits of wide scale distribution of the new findings with its commitment to limiting property rights access.

- **Must Factor Government Constraints on Partner Selection**

The government will also need to consider constraints on selection of teaming partners such as participation by foreign companies. One of the principle motivations behind the dual-use strategy is to use the DOD to enhance U.S. productivity in dealing with international competitors. Controlling foreign access to critical technologies will require detailed knowledge by the government of any potential partner.

d. Cultural Changes Required

An era of wide scale joint ventures within the defense S&T community will require a number of cultural changes at all levels within the organization. At the working level, military lab personnel have been allowed to function more along the lines of a university than a corporation. There are technical 'heavies' within the lab that have a proven track record of research and possess a fair degree of autonomy within a broad technical area.

These technical leaders may work alone or in small teams. As in academia, those with more proven reputations have greater autonomy in defining the work to be done. The friction between researchers within the same organization can be intense enough to heat the lab. Cross fertilization and communication sometimes must be dictated by lab management, and often doesn't occur.

Contact between the defense S&T representatives and their industrial counterparts can occur in a number of ways, ranging from one-on-one chance occurrences to selected targeting of specific organizations by either party. As is the case in any organization, aggressive individuals will have more success in developing these ventures on behalf of their particular area of interest. The problem here is that the lack of cooperation among peers which typifies the labs sometimes leads to less than optimum technologies offered by the government to the joint venture. There is not the sense that industry sponsors in which members within the organization are better off if the best technology is selected. Several joint ventures that fail because of this university mentality within the S&T community will obviously sour industry on teaming.

The government contracting representatives will also have some major adjustments to make. The industry partners should have 'co-equal' status in a successful joint venture relationship. The spin-off attitudes which typified the contracting representatives will also sour any budding relationship. The concept of government/contractor 'co-equal' relationships is a new paradigm for this community. Old ways of doing business will need revision.

Joint ventures will require a new level of commitment within the S&T management structure, as well as the military operating commands (which previously were the sole customer of the S&T community.) Sharing defense resources for non-defense applications could be a bitter pill for some to swallow. With defense downsizing, there are limited people resources available to perform many projects. The inevitable dilution of these

resources to work on some non-defense projects will undoubtedly lead to some frustration regarding priorities within the S&T community.

e. Example

The DOD has been funding research since the mid-1980's to project a laser beam generated on the ground through the atmosphere onto a satellite in space. Military interest in this technology is based on the need to negate hostile satellites during conflict or generate high resolution images of either friendly or hostile satellites during peacetime and wartime. The Air Force Phillips Lab in New Mexico has been performing risk reductions experiments over the past decade to demonstrate the enabling technologies to perform these missions.

During the last year, a concept called power beaming has been discussed within the satellite community, led by the quasi private company COMSAT. The basis of this idea is that the primary cause for removal of their satellites from an operational status has been failure of the battery system providing power during periods when the satellite's solar cells are not exposed to sunlight. In particular, twice a year the satellite has periods as long as an hour each day for about a thirty day period. If a laser beam could be used during these shadow periods to reduce the drawdown of the batteries, COMSAT estimates that the satellite lifetime could be extended by years. This, in turn, would extend the revenue produced by the satellite, as a replacement satellite would not have to be launched on the current time interval of about ten to twelve years.

Proof of principle experiments for power beaming are being planned for this year under a joint venture arrangement between COMSAT, the Phillips Lab, and the Department of Energy's Sandia Lab. One of the major technological challenges to this ambitious project is the ability to minimize the distortions on the laser beam cause by the atmosphere before reaching space. The atmosphere tends to spread the beam and this effect could result in insufficient amounts of power reaching the satellite to charge the batteries. The Phillips Lab, under DOD funding to the tune of tens of milliions of dollars, has developed the

technology to cancel out these atmospheric distortions. This knowledge and high precision optical equipment will be applied to this project.

Sandia Lab has developed a 5 kilowatt laser that will be the source of the laser beam. Their laser will be moved to the Phillips Lab optical range on Kirtland AFB, NM and coupled with the Air Force's optical system to project the beam to space. COMSAT will move a satellite in a geosynchronous orbit (40,000 kilometers above the earth) from a position above the eastern U.S. to a more westerly location within view of the New Mexico optical range.

The objective of the experiment will be to accurately point and maintain the laser beam from the ground to the satellite's solar panels. A COMSAT ground station will then be able to verify that a measurable amount of laser energy did reach the satelllite.

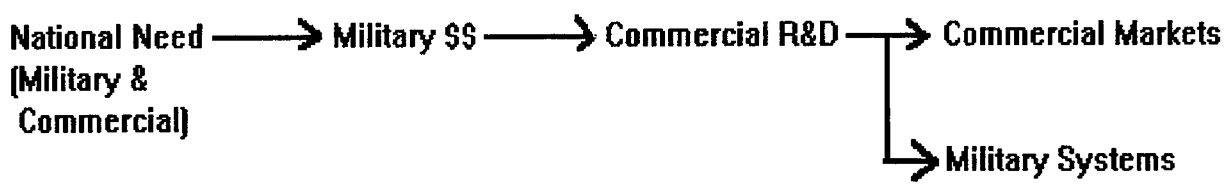
The long term objectives of each of the parties involved differ dramatically. Air Force researchers need to satisfy their customer, Air Force Space Command, whose interests are the military missions discussed earlier. COMSAT representatives have a viable commercial interest in extending satellite lifetime. The extent of their interest can be clearly quantified by the return on their investment. Sandia Lab engineers are trying to find an application for their nuclear pumped laser concept that has yet to find a sponsor.

By focusing on high risk, exploratory development, a common set of research objectives agreeable to all parties can be formulated. At this stage, each team member brings a unique capability that would cost the other more resources than they could muster alone. While the differing objectives of the coalition will ultimately lead to its dissolution, the opportunity exists to meet a common set of near term objectives from which all parties can gain. This type of joint venture arrangement between government and industry can be repeated on a wider, more repetitive scale across the DOD S&T community.

3.0 DEFENSE INFRASTRUCTURE SUPPORT MODEL

a. Model Descriptions

Figure 6a: Military Pull Model Interrelationships



The defense infrastructure support model is based on using defense assets to support a higher national need. There are two offshoots of this model. Figure 6a, the military pull model, represents a derivative in which defense is used to infuse capital into a targeted industry with the primary goal of stimulating a new commercial technology for the private sector. The military may also gain from use of the product, as well.

Figure 6b: Military Support Model Interrelationships

Figure 6b, the military support model, is a second offshoot in which some operational capability within the defense infrastructure is directed to assist in the development of a new commercial product or service. The military pull model can be considered as a

limited form of a national industrial policy, with some higher national economic objective as the driver behind the thrust. An example might be spawning a domestic industry to prepare the U.S. for international competition.

b. Actors Involved

The key players involved in military pull are a subset of those involved in joint ventures, at least at the management level. The same arguments regarding responsiveness improvements by government contracting personnel apply here, as well.

The military support model players will be the operational organizations involved in the supporting role. Impacts on the operational readiness of these support units will have to be considered when committing to these dual-use projects. While economic competitiveness is critically important to the nation's prosperity, the military's primary role is still maintaining preparedness to fight, even in the post Cold War environment. Trade-off in mission readiness with dual-use support will require the attention of senior management within the Defense Department.

c. Key Attributes

- **Based on Higher National Needs**

The national strategy objective, such as reducing trade exports, is translated into more specific objectives such as reducing reliance on Japanese electronics. This, in turn, translates into specific products such as flat panel screens which are expected to be a technology piece of the information superhighway revolution. Defense could then be used as a means for implementing the strategy in a variety of ways. The key here is that the assets of our defense infrastructure are used to achieve this national need.

The redesignation of DARPA to ARPA is an outgrowth of the military pull model being employed. ARPA is leading a multi-departmental government effort in managing Congressionally mandated defense conversion programs. With a rich legacy for developing leading edge technologies, the ARPA organization is effectively executing the national objective of weaning defense industries off military dependency. [Gregory, pp.

51-53] At first glance, one might assume that this effort is really an example of spin-off. However, conversion activities are more appropriately categorized as military pull when the government funds the commercialization of previously defense technologies.

- **Supports Projects Requiring Infrastructure Beyond Industry's Capabilities**

Operational assets within the Defense Department can sometimes be called upon to satisfy the nation's economic objectives. The military support model is of particular relevance with commercial industries which have strong economic value to the nation, but lacks the resources which the military sometimes deploys as part of our defense mission. The use of launch facilities at Cape Canaveral to support commercial space satellites is a clear example of this form of dual-use.

- **Opportunity Costs Regarding Military Readiness Must Be Factored**

These roles for the defense infrastructure will be mandated by Congress. Defense conversion activities are politically attractive and well supported by the American public. However, once the shakeout of defense firms has stabilized, some difficult decisions must be made regarding proper roles and missions for our military services (and intelligence organizations) in the post Cold War era. There may well be opportunity costs in terms of readiness postures associated with large scale commitment of the defense infrastructure toward commercialization of dual-use technologies.

d. Cultural Changes Required

The high level support for this type of dual-use interaction almost guarantees the best efforts by defense personnel. As already has been discussed, the responsiveness of government people to industries needs must be improved. For example, the Air Force is aggressively teaming with their aerospace industry counterparts to provide launch services for satellites in direct competition with the French government/industry team. In organizing the U.S. team, Major General Dickman has acknowledged that his government personnel must change how they do routinely do business to minimize the expenses of their industry teammates. Prior to this time, the government showed little concern if Air

Force operations resulted in overtime expenses for the McDonnell Douglas launch team, since the extra expenses came out of their corporate profits. [Banke, p.1A] Global competition requires a more cooperative government/industry relationship than previous times when we were the only game in town.

e. Examples

The Technology Reinvestment Project (TRP) managed by ARPA is an excellent example of the military pull model. The program was generated to meet the nation's need of converting a large portion of the defense industrial base to commercial products in the post Cold War era. About $472 million was appropriated by Congress in FY93 for eight separate programs that are included under the TRP umbrella. The effort is truly interdepartmental, with participation by the National Institute of Standards and Technology, the National Science Foundation, the Department of Energy, and the National Aeronautics and Space Administration. [Gregory, p.51]

While some industry leaders have publicly blasted the concept, the TRP represents an attempt by the government to enhance our international competitiveness by redirecting U.S. industrial focus away from the military toward commercial markets. ARPA is being used as a catalyst for spurring defense conversion efforts on a faster timescale and with less negative impacts to our economy than would occur without government intervention. However, the public statements by ARPA officials explaining their organization's role in conversion activities reflect sensitivity to criticism regarding dilution of their primary responsibility - sponsoring development of leading edge technologies to enhance our military warfighting capabilities. [Buchanan, pp.12-15]

There certainly is some opportunity costs associated with overseeing such a large endeaver. But, these criticism's are effectively deflected in today's political climate in which the benefits to the nation of a successful defense conversion far exceed the perceived costs of not focusing all defense R&D resources on a high tech agenda.

An example of the military support model in practice is the active role that the Air Force Space Command is taking in supporting the U.S. space launch industry. Until the Challenger disaster, the U.S. mistakenly curtailed its support for an expendable launch vehicle capability, with almost blind reliance on the shuttle for getting our satellites deployed. During this period, the European consortium, Arianespace, capitalized by capturing over 70% of the international space launch market. [Thompson, p.1A]

The government, under the leadership of Brigidier General Robert Dickman, has been very vocal in its support for recapturing a large share of this market for U.S. companies. In a head-on attack on Arianespace, General Dickman has pledged a number of infrastructure improvements at Cape Canaveral to the tune of $1.1 billion through 2002 to lure more business to Florida. [Banke, p.1A] The open effort by the government to maintain a domestic space launch capability represents a partnership with U.S. industry that typifies dual-use relationships under the military support model.

CONCLUDING REMARKS

Regardless of whether dual-use technologies are implemented within the DOD, the primary objective of defense science and technology programs will remain to field the very best weapon systems for our fighting forces. Any additional goals such as enhancing our economic competitiveness will be secondary objectives for defense acquisition. So the real question is whether any of the alternatives to the baseline spin-off model offer more 'bang for the limited defense bucks.' Clearly, there will be support for any model that generates significant savings with widespread use of commercial technologies without compromising mission performance. If this were easy, it'd have been done long ago. So what's changed that leads us to believe that dual-use alternatives now make sense?

The Cold War era required many military systems to operate during a nuclear conflict. Nuclear hardening created the need for technology unique to defense. Our military systems were previously designed with enough flexibility to allow for operation in any

theater of operations. Our systems could function in either the rugged terrain of Europe or the sands of the Persian Gulf. Surviving the shake, rattle and roll tests exacted another set of performance requirements also unique to defense. And the introduction of stealth technology into our forces fueled an ever widening rift between military and commercial systems.

The post Cold War era marks the dawn of new roles for our military forces. Some of the new missions include peacekeeping, hurricane relief, and even peacemaking. More specific to this discussion, what do these new missions mean in terms of commonalty between commercial and military systems? Clearly, the need for radiation hardened hardware has diminished, which encourages spin-on and joint ventures. Beyond this safe statement, it's a very difficult call.

There are two arguments that are used in favor of alternatives to spin-off, given the need for continued flexibility in our deployment capabilities (and regardless of our force structure size.) The first is that the spin-off paradigm has led to such dramatic overspecification in our mil-specs that most of them can be eliminated without impacting our ability to perform on the battlefield.

This is a very bold assertion that begs for detailed review before betting the farm on its accuracy. While there have been volumes of studies on this aspect of acquisition reform, the studies are so broad and high level that they add very little understanding to the engineering implications of the thrust away from mil-specs. The arguments cite as proof the obvious cases of overspecification such as the infamous fruit cake specs. But this level of symbolic discussion is not sufficient to justify the paradigm shift. Serious analysis of the impact of shifting to alternative models cannot be conducted on the political level, but rather in engineering, cost, and strategy frames of reference.

The second path of reasoning to support the shift toward spin-on is based on acceptance of the reality that some fraction of less capable equipment within our force structure may be sufficient to support military missions of the future. For example, do all

vehicles assigned to combat units need to have off-road capabilities? We observed this limitation in the Persian Gulf conflict with some commercial trucks deployed to the region. The units were able to deal with this constraint by confining their use to rear depot areas. While no commander likes operational constraints, such performance/cost/mission trades may be advantageous in a limited budget environment.

In reality, it is most probable that each of these dual-use models will be employed to some degree throughout the DOD. A cautious approach toward slowly easing into a mix of dual-use models has appeal when we consider the consequences of boldly moving in a direction that reduces our fighting effectiveness. However, the cautious mixed relationship approach toward implementing dual-use technologies has drawbacks.

From our review of these models, differences emerged in the cultures required to make each model work. Dramatic shifts in the attitudes, behaviors, and even composition of the S&T and Contracting communities were called for in implementing the spin-on and joint venture models. A mixed relationship approach requires policies that either foster the existence of multiple cultures, or accept the particular culture of one model and expects the people to perform with the attributes of a different model. And the costs to maintain mixed cultures may even be higher than continuing solely under spin-off.

Should we then accept the need to move away from spin-off, a second major concern surfaced in our review - the need to revise the requirements generation process if the spin-on approach is adopted. Referring back to the relationship model of figure 4, the iterative loop required for performance/cost/mission trades should not be discounted as a minor change. Significant revisions to acquisition regulations in defining the requirements should be in-place before (or at the very least in parallel with) attempting any pilot programs.

A third issue to emerge is the complexity of identifying the dual-use opportunities with the proper government/industry relationship model. This paper is a first attempt to propose that the relationship dimension must be addressed in any relevant strategy to implement dual-use technologies.

The differing perspectives of government and industry in any joint venture relationship requires particular attention in developing research objectives that can sustain the long term support of both parties. The flexibility necessary to factor these perspectives into any agreement supports decentralized control and execution within the S&T community under a shift to dual-use.

The fourth major issue to surface may dwarf all other concerns. Specifically, the cost savings realized with lower R&D and procurement costs by shifting to spin-on must exceed any increased costs incurred because of additional support requirements during the lifetime of the fielded system. A primary political motivation for implementing dual-use technologies is to shift some portion of the nations R&D investment from defense into technologies that enhance our international competitiveness. If defense R&D reductions are offset by increased logistics support, then the net results of the shift to dual-use technologies would be higher national debt and possibly lower force projection capabilities. Clearly, this in not our intent in pursuing this path. The impacts on the tail-end of the acquisition cycle must be weighed heavily at the outset of each program, particularly under the spin-on paradigm.

Even if cost savings are achieved with a shift to dual-use, there probably still needs to be some incentives provided to the acquisition and operational communities to support the change. Simply dictating a new way of doing business from the top may result in a flurry of activities, but little in the way of lasting effects. Some financial incentives should be considered to entice the paradigm shift within these communities such as allowing a fraction of the savings to remain within DOD. Thus, if the national goal is to shift say 10% from defense to commercial R&D, this might translate into an actual 12-15% bogey levied on the S&T community, with the difference used to motivate the defense actors.

Our understanding continues to mature regarding what a shift from spin-off acquisition will mean. Most, if not all, of the discussion has been an inside-the-beltway affair conducted at an extremely top level. This paper was an attempt to lower the plane of

reference several notches to begin understanding what infrastructure conditions are needed to make the shift successful. I consciously tried to avoid passing judgment on any particular model and instead provide an objective characterization of each perspective government/industry model.

Much study is still necessary at a detailed working level to determine the 'right' mix of dual-use opportunities and relationships within the Department of Defense. This is the time when the seeds of these new paradigms will be planted in either top soil or the desert sands. Whether the roots of change grow or whither will be determined by the quality and intellectual honesty we are willing to devote toward these discussions.

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APPENDIX 1: IMPACTS OF THE DUAL-USE RELATIONS ON THE NEW DEFENSE ACQUISITION STRATEGIES

The standard acquisition cycle of the past is undergoing major revisions. Future weapon development and procurement are envisioned to follow several paths: [CRS, p.4]

- Selective upgrading of weapon systems or subsystems
- Low-rate procurement of systems to preserve a critical part of the industrial base
- "Rollover-plus" in which prototypes are cycled through several development iterations before ever being sent to production
- Procurement of limited quantities of new weapons that provide revolutionary improvements in our warfighting capabilities

Given the characterizations of the dual-use models just discussed, we might wonder if any of the relationships couple uniquely into these acquisition strategies? The upgrade of existing weapons might be the most straightforward to deal with. Initially, the upgrades might differ from a commercial counterpart to a sufficient degree in fit, form, or function such that a spin-off approach may still be needed.

However, there may be a significant number of opportunities at the component and subsystem levels where some form of joint venture development might be warranted. The first generation of upgrades may have sufficient differences between the military and commercial product to produce slightly varying products. However, one might envision that the joint venture may lead to a true spin-on possibility for the second generation upgrade.

The low-rate procurement of systems to maintain part of the industrial base may be dominated with spin-off technologies to a considerable extent. Afterall, the lack of a civilian counterpart is exactly the reason that this form of procurement was being funded in the first place. However, the potential for spin-on at the component level may still be a

credible option for minimizing the size of the industrial base having to be bankrolled with defense dollars.

The "rollover-plus" option offers the greatest opportunity for experimenting with spin-on technologies. Without having to deal with the concern of a prototype design that will immediately be implemented into a large production lot, there should be less aversion to risk taking during R&D. Until spin-on has been widely accepted within the DOD acquisition community, prototypes provide a unique opportunity to verify the performance-cost-requirement trades previously discussed.

The type of system being acquired will also have some relevance here. Components used in systems that operate near or behind the forward edge of the battle area may have more stringent performance requirements than commercial counterparts. The DOD's willingness to accept the added risks of spin-on or joint ventures will be much higher for systems which operate in rear echelons or for missions where soldiers lives are not at stake.